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Materiel Test Procedure 2-2-621*
Aberdeen Proving Ground

U. S. ARMY TEST AND EVALUATION COMMAND
COMMON ENGINEERING TEST PROCEDURE

VEHICLE COLLISION AND ACCIDENT SAFETY TEST

1. OBJECTIVE

The objective of this test procedure is to provide guidance for planning destructive tests to determine the safety limitations of vehicles subjected to collisions and other accidents.

2. BACKGROUND

A tentative evaluation of operational safety is standard procedure for a new vehicle during preliminary operations, MTP 2-2-505, and various safety aspects are thoroughly evaluated during the ensuing course of the engineering test, MTP 2-2-508. In many instances it is impracticable to include destructive collision and accident tests due to the scarcity and non-expendability of test vehicles. Such tests are very desirable, however, for a new vehicle having an essentially new automotive structural configuration, and they are planned to simulate the more probable accident situations of service use. Only test-weary vehicles and components are used for this purpose, and the tests are planned as a final phase of the engineering test. SAE test procedures J857 and J850 provide additional planning assistance.

The concept of accident safety testing is to test the complete automotive system as to damage resulting from typical accident situations. Wheeled and tracklaying vehicles are tested with simulated combat loads, including personnel, stowage, fuel, and ammunition. For each type of vehicle design a special test plan is required to provide an appropriate series of tests.

Because of the limited number of vehicles for destructive testing, only certain extreme accident conditions are investigated. These include two general accident types: collision with an immovable barrier, and rollover. Other hazardous conditions are appropriate for special purpose vehicles - for example, accidental sinking of armored personnel carriers, tire blowouts, and entrance and exit hazards during fording. The system concept of accident investigation should be considered in test planning.

Test severity is planned to carry the item from the least severe to the most severe conditions. Thus, testing usually proceeds from low speeds up to the point of incipient damage or crush-up and then at the maximum test speed. Rollover tests begin with a "static" roll and proceed to a maximum test speed. Special automotive structures such as trailed loads and articulated vehicles require more specialized accident simulations. Tire blowout tests are simulated at various speeds.

* Supersedes Interim Pamphlet 60-311

3. REQUIRED EQUIPMENT

a. Test Vehicles
b. Parallel Roads
c. Displacement Gages
d. Strain Gages
e. Anthropomorphic Dummies
f. Rollover Facility
g. Communication Equipment (Radio)
h. Crane
i. Munson Turning Circle
j. Cameras
k. Large Massive Barrior

4. REFERENCES

A. MTP 2-2-502, Inspections
B. MTP 2-2-505, Preliminary Operation
C. MTP 2-2-508, Safety Evaluation
D. MTP 2-2-500, Vehicle Characteristics
E. MTP 2-2-800, Center of Gravity
F. SAE J857, SAE Recommended Practice: Rollover Tests without Collision
G. SAE J850, SAE Recommended Practice: Barrier Collision Tests

5. SCOPE

5.1 SUMMARY

This pamphlet discusses the factors involved in planning collision and accident safety tests, outlines vehicle rollover and collision procedures, and furnishes damage criteria and evaluation objectives. It describes the following collision tests to be conducted on a vehicle.

5.2 LIMITATIONS

The pamphlet does not consider all aspects of accident hazards for each specific design of vehicle; it provides generalized guidance for planning appropriate test and accident situations.

6. PROCEDURE

6.1 PREPARATION FOR TEST

Vehicle characteristics are recorded in accordance with MTP 2-2-500. Center of Gravity is determined in accordance with MTP 2-2-800. Combat weight is obtained with specified wheel loading distribution. MTP's 2-2-502 and 2-2-505, apply.

6.1.1 Pre-Scheduling Conditions

An instrumentation plan is prepared specifying each measurement and test condition, extent of data accuracy required, and method of reporting. Instrumentation is required for recording the basic accident vehicle impact phenomena in order to calculate effects at other speeds and test conditions. Dynamic loads on payloads or personnel are recorded. Remote control of the test vehicle requires other special instrumentation. Cameras and strain gages or displacement gages are placed in positions where the appropriate information may be recorded. Anthropomorphic dummies are to be used in place of personnel where possible.

a. Rollover Tests - A rollover test to tip the running vehicle over on its side or top. This is a progressively increasing side-sloped ramp that is approached at high speed. In the case of rolling over due to turning, the Munson Turning Circle is employed, with suitable safety devices.

b. Collision Test - An essentially immovable object is either firmly emplaced or has a 1:100 vehicle-to-obstacle mass (lower - 1:10 - mass ratio is acceptable if the obstacle is firmly emplaced). For this test parallel road are required - one for the test vehicle and obstacle, another for the towing and "chase" or instrument vehicles. These roadways must be sufficiently long to permit attaining the required maximum test speed before impact. A turnoff and braking area is also needed.

6.1.2 Pre-Testing Conditions

The project engineer must study all safety aspects of the test to ensure that it will be conducted with minimum hazards. The roadway should be studied for effects of the high-speed testing on other traffic. Access to the impacted test item is needed to extinguish fires, make repairs, and for salvage. Safety disconnects will be used for remote vehicle controls. Secondary backup mechanical procedures are necessary in case electrical controls fail.

Spectators will be suitably protected from flying fragments, and other hazards.

A safety standing operating procedure is prepared to cover test methods and precautions. Project engineers must design the test to permit a stop at any time the test becomes unsafe. Radio or visual signals may be used for communication with the project engineer.

Special tests such as amphibious vehicle submersions necessitate the design of special safety procedures, instrumentation, and facilities for the particular test.

6.2 TEST CONDUCT

At least two vehicles are required, one for rollover and one for collision test phases. Repairs are made economically (after damage analysis)

to return the vehicle to its original condition. Each test is separately planned.

6.2.1 Rollover Tests

a. With the conditions as specified in paragraph 6.1.1, connect a crane to one side of the test vehicle. Tip the vehicle on its opposite side. Record data as appropriate to the conditions created by the test.
b. Start the vehicle and approach the rollover ramp at minimum speed. (The test vehicle can be towed or remotely controlled onto the ramp).
c. Allow the vehicle to turn over and record data as in step a.
d. Repeat the test at intermediate speed so that the vehicle rolls both on its side and top. Record data as was previously done.
e. Repeat the test at maximum rated speed and record data as before.

6.2.2 Collision Tests

a. Instrument the vehicle as indicated in paragraph 6.1.1.
b. Drive or tow the vehicle into a large immovable or massive object at low speed. A second vehicle mounting instrumentation is driven along side the vehicle being tested to record base line data.
c. Repeat the test at sufficient speed to cause approximately one-half bumper-to-vehicle from crushup displacement that could occur.
d. Repeat the test at sufficient speed to cause maximum bumper crushup displacement.
e. Repeat the test at maximum rated speed.

6.3 TEST DATA

The following data are recorded:

a. Acceleration in ft/sec
b. Displacement in feet
c. Stress in percent
d. The time from the beginning to the end of the test in seconds.

6.4 DATA REDUCTION AND PRESENTATION

Each condition is evaluated from damages sustained. Damage and estimated repair costs are correlated with recorded displacement time data. Damage is estimated as the limiting vehicle speed at which damage occurs to:

a. Personnel
b. Stowage
c. Major component
d. Vehicle structure

Data are obtained so that estimates may be drawn of the severity of damage that will occur at intermediate and higher impact speeds.

Evaluation of the deceleration rates along with damage sustained will be used to compare the safety limitations of the test vehicle with those of similar vehicles.

The need for design improvements may become apparent during the test analysis.

The following graphs are plotted:

a. Acceleration versus time - Deceleration of vehicle center of gravity and important components (including anthropormorphic dummies) is noted.

b. Velocity versus time - This information is required for both vehicle and components prior to impact.

c. Displacement versus time - Displacement of important components is measured by camera and displacement gages.

d. Stress versus time - Strain gage data showing impact strain on important structural elements are required for extrapolation to higher impacting speeds.